Implementation of CAD Standard for Building Information Model (BIM)

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Abstract

Current CAD standards have been mainly developed for only 2D drawings. Thus all file names and level/layer conventions in commercial CAD software programs are developed only for the traditional 2D drafting process. CAD is based on traditional drawings as a whole while BIM is focused on individual objects and providing various levels of information associated with the objects. However, the existing file naming and level/layer conventions are not applicable for 3D models. The main objective of this paper is to address and suggest file naming rules and a level/layer system in developing more efficient 3D BIM models. Furthermore, the developed conventions provide less impact on the existing CAD standards.

Key words: BIM, CAD, 2D, 3D, CAD standard

. Introduction

According to the National Institute of Building Sciences (NIBS), the CAD standards streamline and simplify the exchange of building design and construction data from the project development throughout a life of the building (2006a). For the implementation of CAD standards, NIBS (2005) addresses three principal advantages: (1) a common language of data classification and organization for CAD will improve communication and data transfer among building design and construction teams, helping to streamline the building design and construction process, (2) a national CAD standard (NCS) will provide one component of a coherent and consistent electronic “information model,” or database, which can be made available throughout the life cycle of the building, for purposes other than the original construction, (3) a single, nation-wide data classification and organization system for CAD will simplify the transfer of

building data from the original building design CAD applications to facility management (FM) applications.

In spite of its main purpose and advantages, current CAD standard has been developed for only 2D drawings. Thus all file names (e.g., dwg, ifc, and dgn) and level/layer conventions in commercial CAD software programs have been developed for only the traditional 2D drafting process. There are significant differences in data structure between CAD and BIM. CAD is based on traditional drawings as a whole while BIM is focused on individual objects and providing various levels of information associated with the objects (NCS 2006b). However, the 3D models created in the BIM are different from the existing 2D CAD standards and they are referenced in forms of extracted or exported drawings as independent objects (Figure 1).

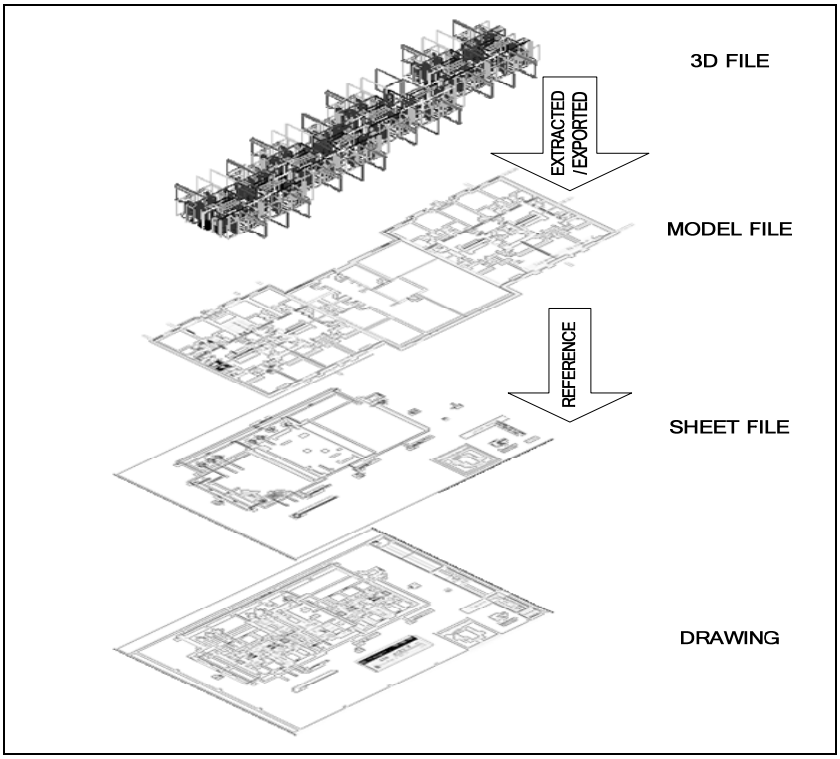

Figure 1. Drawing Composition for BIM Project

For this reason, existing file naming and level/layer conventions are not applicable for 3D models. In an attempt to develop CAD standards for 3D drawings, it is recommended that the following items be considered: (1) keeping the existing convention rules to minimize impacts of changes on existing standards, and (2) providing adaptable information used for building project information such as quantity takeoff and scheduling. Therefore, the main objective of this paper is to

address and suggest file naming rules and a level/layer system in developing more efficient 3D BIM models.

. Existing CAD Standard

.1 File Naming

According to the National CAD standard (NCS), two types of drawing are recommended to composite electronic drawing files: a model file and a sheet file. Similarly, on the A/E/C CADD Standard, the CADD/GIS Technology Center (2001) explains more details on two file types: a model file and a sheet file. A model file contains the physical components of a building (e.g., columns, walls, windows, ductwork, piping, etc.). A model file is drawn at a full scale and typically represents plans, elevations, and sections. A sheet file (a.k.a., a plotted CADD drawing file) is a selected view or portion of the model file(s) within a border sheet. A sheet file is usually plotted at a particular scale, since the border sheet is scaled up to fit to a full scale model file. In other words, a sheet file is a "ready-to-plot" CADD file.

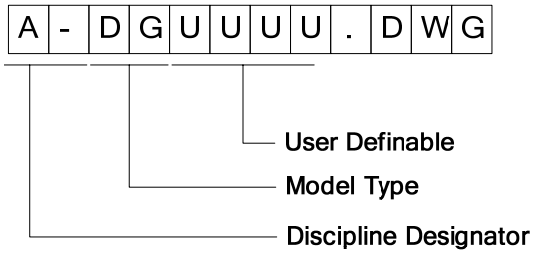

Figure 2. Model File Naming Convention (NIBS 2005)

Figure 2 shows a file naming convention for a model file type based on NCS: the first two characters field is for discipline designator, the second two characters field presents a model file type and the next four characters field is user definable. Table 1 shows examples of model file types for the architectural discipline.

Model File Types	
FP	Floor Plan
SP	Site Plan
DP	Demolition Plan
QP	Equipment Plan
XP	Existing Plan
EL	Elevation
SC	Section
DT	Detail
SH	Schedule
3D	Isometric/3D
DG	Diagrams

Table 1. Example of Model File Types (NIBS 2005)

.2 Level/Layer Name Format

CADD levels or layers are analogous to overlays in manual drafting systems and serve to separate graphic elements (lines, shapes, and text) according to the design discipline they represent. While the NCS and ISO 13567 differ somewhat in their approach to standards for CAD layers, they are alike in several important respects. Both standards (Table 2) specify the names of the data fields that make up a typical layer name, define the field names, specify which fields are mandatory (required) and which fields are optional, specify the number of characters in each field, and specify the order in which the fields are to appear (NIBS 2005).

NCS Field Name	ISO Field Name
Discipline Designator	Agent Responsible
Major & Minor Group	Element
Annotation Minor Groups	Presentation
Status	Status

Table 2. Field Name Comparison Table (NIBS 2005)

Figure 3 shows a typical layer name convention format: the first two characters field shows discipline designator, the next four characters field presents a major group identifying a major building system, and the rest of the remaining fields are optional including a minor group, a 2nd minor group, and optional status code.

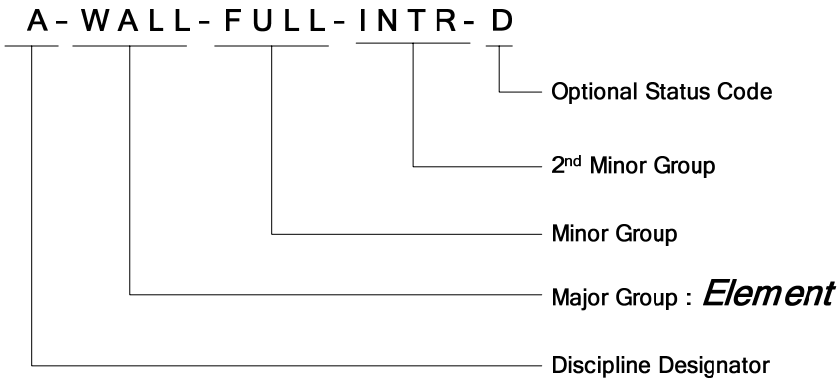

Figure 3. Level/Layer Naming Format
(The CADD/GIS Technology Center. 2001)

.3 Evaluation

Although the NCS names a '3D' for Isometric/3D drawings, there is no detailed information for organizing a 3D file, which makes it difficult to be applied to the current BIM concept requiring more intelligent building models. Only the user defined field is allowed to add more information for the 3D file organization. Also, although objects standards such as IFC and CIS/2 have been developed for BIM, the functions to turn on or off level/layers in CAD software programs seem to be remained for the following reasons: (1) turning on or off levels/ layers by a major group, (2) providing detailed information on the levels/layers such as materials or functions of elements, and (3) providing a convenient way to remap the levels/layers between 3D models and 2D drawings which are either imported or exported. Similarly, Huell (2006) points out that all objects must be assigned to a level/layer and addresses that there is no way to account for all possibilities dealing with objects and level/layer.

. Proposed CAD Standard Framework for BIM

Once a project begins, multiple architects would work concurrently. It would be more time efficient if the CAD models can be divided into separate files based on certain rules, so that multiple architects or detailers can work for one CAD model at the same time maybe in different locations. In such a situation, it would be helpful to have common or standard additional information on the CAD model including facility/area numbers and space/floor numbers or codes (Figure 4). This additional information can be useful not only for the construction process but also for operation and maintenance of the facilities. In automated construction scheduling or estimating process, a floor system for general building project can be used as a framework in general building projects for the composition of files as a part of work breakdown structure in a general building project in terms of cost

and schedule.

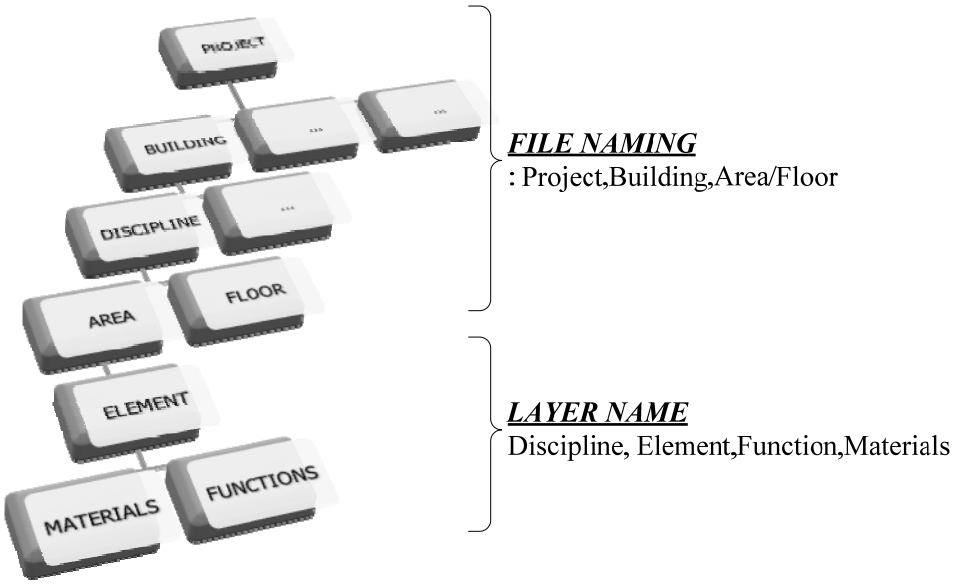

Figure 4. Framework for BIM Standard

.1 Proposing File Naming

While NCS doesn't specify any project code for file naming, A/E/C CADD standard addresses to use 0~20 characters for a project code. To indicate additional information on a building, this field can be used not only for project code but also for a building number and more. Based on NCS, a four characters field is provided to add a user defined code, and it could be used to specify floor or zone/area.

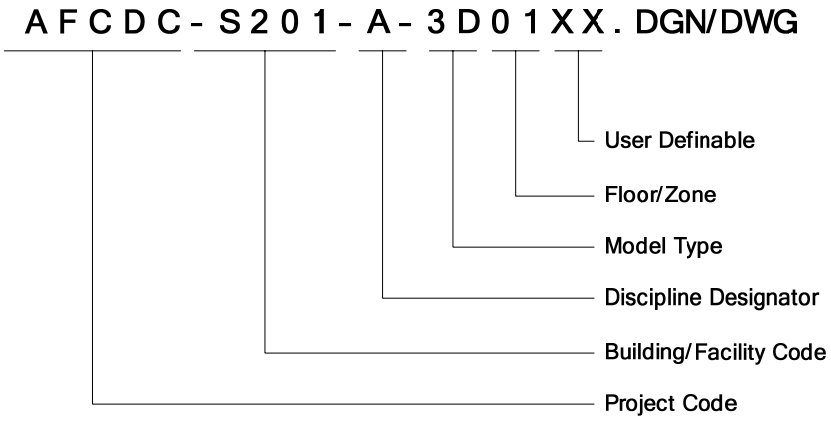

Figure 5. Proposing File Naming

Figure5 shows an example of proposed file naming convention: 'AFCDC' is the project code, 'S201' is the building number, 'A-' is a discipline designator, '3D' is a model type, '01' is a floor number, and 'XX' shows a user characters field which

can be used for specific status. This rule can provide a framework of WBS for specific project.

.2 Proposed Level/Layer Name

Although NCS provides a framework to use a major group for the element definition, the rule for a minor group is not defined. Object definition containing information on function and material of element for object would help to use a level/layer system in most of the CADD systems. This paper suggests using minor groups to present functions and material's order in addition to existing element definition for major group.

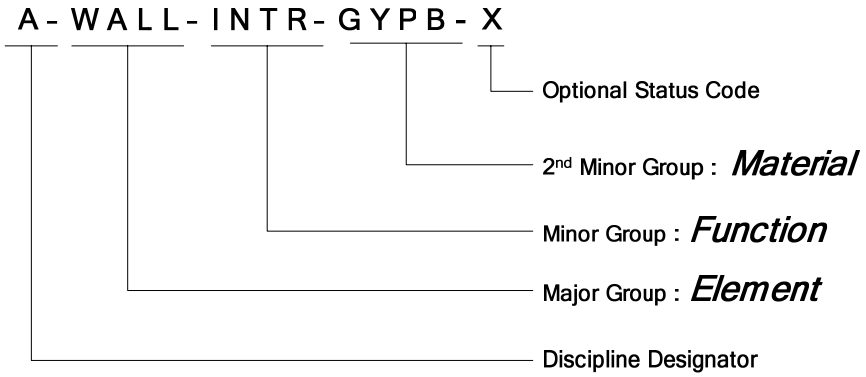

Figure 6. Proposing Level/Layer Name

Figure 6 illustrates an example of proposed level/layer naming rule: 'A' is a discipline designator, 'WALL' is a major group standing for specific element, 'INTR' is a minor group and stands for 'Interior' to describe function, 'GYPB' is a 2^{nd} minor group describing material of object, and the last character is a status code to present conditions such as existing and demolition etc. This can provide a flexible way to turn on/off 3D object for develop models.

This convention can be used not only for 3D models but also for 2D drawings extracting or exporting from models. The major group can be used to remap levels/layers between 3D elements and extracted or exported 2D drawing elements with the existing 2D level/layer system.

. Case Study

A few prototypes for BIM projects have been developed using the proposed method. Figure 7 shows one of the prototype projects: this project consists of two phases. One is to renovate an existing building and the other is to build an addition connected with the existing building. This building has been divided into two logical areas using 'E', and 'A' in user defined field. Architectural and structural models have been modeled using the proposed level/layer name. Extracted 2D

plan drawings are 90% compliant with current standard. The quantity takeoff has been taken from 3D Models using file name convention, and schedule simulation has been established using WBS which is defined as file name.

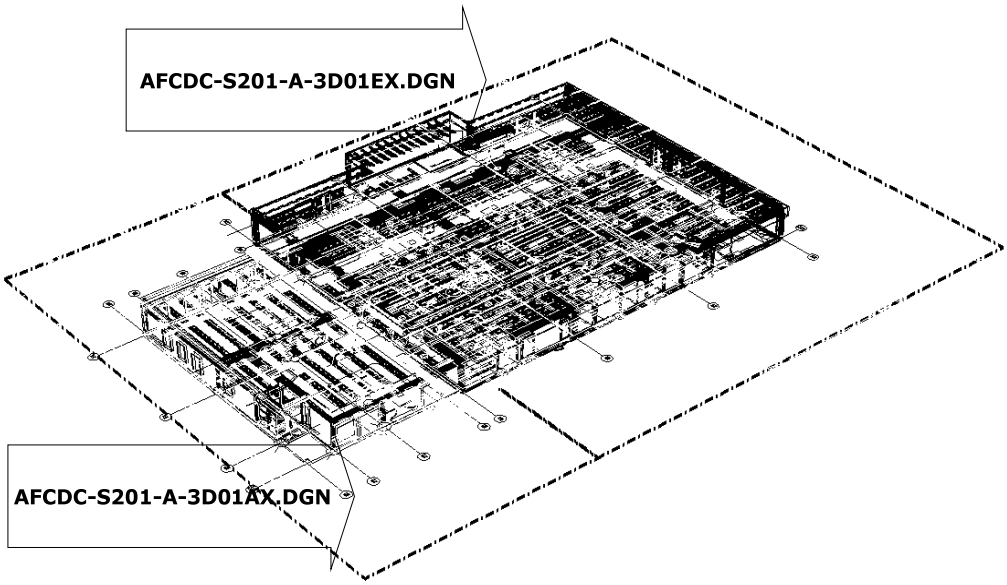

Figure 7. Application of Proposing Standard

. Conclusions and Recommendations

The proposed file naming rule can intelligently provide detailed full information about a project, buildings, disciplines, areas, and floors. For a level/layer system while following existing 2D standards, extensible values to reproduce 2D drawings with 3D modeling throughout the project life cycle is suggested in this paper. These suggesting conventions in this study have been used for selected prototype projects, and have been evaluated as applicable for general building projects. Furthermore, the proposed conventions can provide less impact on existing CAD standard because it's following existing 2D CAD standard and provides more flexible way to use user defined code to present object definition such as function/material. Future challenges include defining physical building grouping based on construction joints. Vertical groups such as exterior walls and structural column are differing from physical floor system. Also, multiple stories in single building project would be considered. For level/layer naming, more verifications are required because still the arguments between function and material are under evaluation.

. **References**

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